

Historical Shark Meat Consumption and Trade Trends in a Global Richness Hotspot

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Abstract Shark catches have increased worldwide, threatening the survival of several species. This study describes historical trends concerning shark consumption and commercialization by artisanal fishers in northeastern Brazil. Semi-structured questionnaires were applied and respondents pointed out that sharks used to be locally regarded as low-quality fish in the past and rejected by fish consumers, with low fisher consumption frequency. However, this has changed in recent decades, as a total of 95.4% (n=62) of the questionnaire respondents reported currently consuming shark meat, while 61.5% (n=40) highlighted its high quality. In addition, most interviewees (90.8%; n=59) reported decreasing numbers of sharks caught over time, following worldwide trends, leading to decreased fisher access to shark meat. Because of this, most respondents (70.7%, n=46) now consider it more advantageous to sell the sharks they catch than to consume them. In addition, the local commercialization of these fish is currently based on immature coastal species (<1 m). Thus, economic and biological studies on local shark populations are suggested in order to preserve local fisher culture and ensure food security for artisanal fisher communities and a long-term sustainable fishery and conservation of exploited species.

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Introduction

Sharks belong to the class Chondrichthyes and play a crucial role in marine ecosystems, acting as ecological stabilizers due to the evolutionary pressure they exert on their prey (Heupel et al. 2014). Most shark species exhibit K-strategist characteristics, with a limited capacity for population recovery and are, therefore, naturally susceptible to overfishing (Dulvy et al. 2017; Ward-Paige et al. 2012). In fact, most shark populations are currently under serious threats, with close to a quarter of all species at risk for extinction (Dulvy et al. 2014). However, despite their high vulnerability, shark fishing has intensified worldwide

over the past three decades with shark meat, fins, cartilage, skin, oil, teeth, jaws, and even gill rakers reaching high market values (Lack and Sant 2009), and worldwide catches have been estimated as ranging between 63 and 262 million individuals annually (Worm et al. 2013).

In this scenario, sharks have become one of the most versatile and valuable fishery resources, serving as an important protein source in developing countries and contributing towards human food security (Bornatowski et al. 2018a; Dulvy et al. 2017), defined by the United Nations as “when all people at all times have physical and economic access to

sufficient, safe and nutritious food to meet their dietary needs and food preference for an active healthy life” (United Nations 2014). In addition, they are also a source of luxury items in several countries: e.g., in the form of shark fin consumption (Fowler et al. 2005). Thus, urgent conservation measures aiming at both shark protection actions and human food security maintenance are required, the latter focused primarily on poor and developing countries (Dulvy et al. 2017).

Ethnozoological information is considered essential for animal conservation strategy planning, as human activities have been identified as the main causes of direct and/or indirect threats to many animal groups, especially vertebrates (Alves and Souto 2015). In this sense, ethnoichthyological studies are paramount for the development of sustainable shark use, allowing for ichthyofaunal resource preservation and fishing culture maintenance (Begossi et al. 2017; Castro et al. 2016; Pinto et al. 2015). Thus, to achieve long-term sustainable use of a particular faunal resource, an ecological perspective must be applied in order to assess and understand the mechanisms and motivations that guide the human-faunal connection—in this case, sharks—including fisher shark knowledge, uses, and management (Barbosa-Filho et al. 2017).

Shark research in Brazil has increased in recent years, but studies focusing on the human dimension of shark fishing are still scarce, both in the country (Barbosa-Filho et al. 2014) and worldwide (Simpfendorfer et al. 2011). In this context, this study analyzed historical shark meat consumption and trade trends by fishers in southern Bahia, northeastern Brazil, and discusses possible conservation strategies, linking these data to the livelihood and food security maintenance of artisanal fishers in this coastal area.

Materials and Methods

The present study was carried out in fishing communities located along the coast of the state of Bahia, in northeastern Brazil. Southern Bahia is a priority conservation area, as it encompasses both the coastal marine biome and the Atlantic Rainforest, and is considered a major biodiversity hotspot (Tabarelli et al. 2005). Specifically concerning the marine environment, this region is also noteworthy as one of the main worldwide functional diversity endemism and shark species richness hotspots (Lucifora et al. 2011).

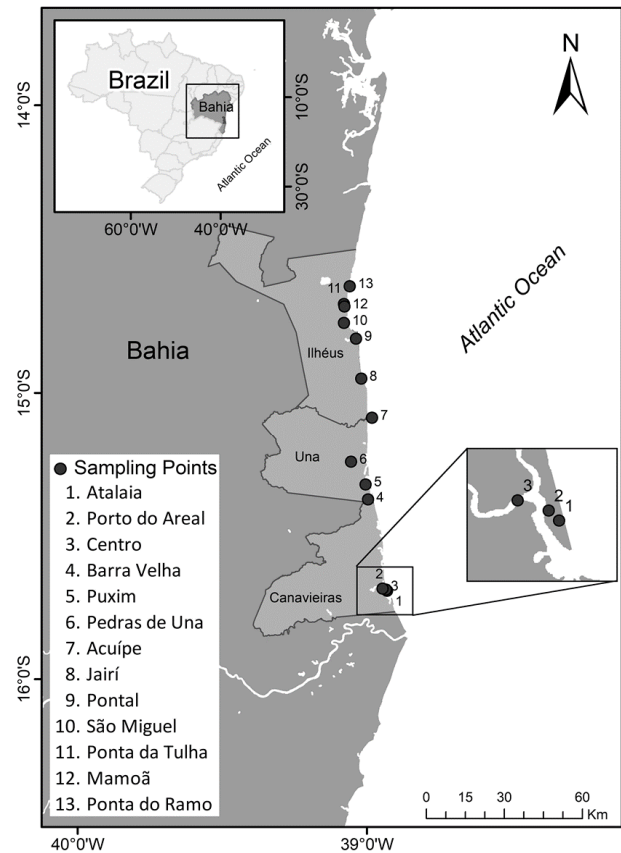


Figure 1 Fishing communities along the coast of the state of Bahia, Northeastern Brazil, where interviews were conducted with artisanal fishers regarding shark consumption and marketing.

The study area includes the cities of Ilhéus, Una, and Canavieiras, comprising approximately 175 km of coastline ($14^{\circ}24'31''$ S and $39^{\circ}00'57''$ W to $15^{\circ}49'09''$ S and $38^{\circ}53'46''$ W) and about 242,000 inhabitants. Marine fisheries in this area present a strong artisanal and cultural character (Barbosa-Filho and Cetra 2007; Erler et al. 2015), with traditional knowledge applied to catching shelf-break reef fish with high commercial value spanning over four centuries (Olavo et al. 2005). At least 13 marine landing sites and/or communities (Figure 1) are located in the study area, where fish capture efforts are the prevailing activity.

Semi-structured interviews were performed between February and October 2012, totalling 65 respondents. All interviews were recorded by means of a digital recorder, yielding a total of 70 hours and 20 minutes of recordings. Respondent selection was carried out through a network of native experts

(Marques 2001), comprising reputable people recognized by the community as having a broad cultural knowledge concerning fishing activities. In addition, interviewees were also required to have experience in catching sharks in the region for at least 15 years. The applied form is available as a supplementary file.

A qualitative approach was used to examine fisher knowledge regarding shark uses by integrating various individual competencies in which all provided information was considered. A quantitative approach was also performed through descriptive statistical techniques, primarily focusing on the frequencies of fisher responses.

The main species consumed and marketed by the participants were recognized by comparing common names cited by respondents to those reported in the scientific literature (Figueiredo 1977, Gadig 1994; Pinto et al. 2015), and also by assessing specific information for the state of Bahia (Giglio et al. 2015; Queiroz and Rebouças 1995).

Results and Discussion

The popular and scientific names of the most consumed shark species marketed in the study area according to the fishermen are displayed in Table 1, alongside their conservation status, both in Brazil (decreed by ordinance 445) and worldwide.

A total of 95.4% (n=62) of the questionnaire respondents reported currently consuming shark meat, while 61.5% (n=40) highlighted its high quality, attributing this to good taste, smoothness, and lack of bones, corroborating reports indicating that shark meat demands overall have increased worldwide (Dent and Clarke 2015). Brazil is the world's largest

fish meat importer (Dent and Clarke 2015) and it is suspected as acting as a channel for the global shark carcass flow (Bornatowski et al. 2018b). Several populations living in urban centers have also displayed increasing interest in consuming shark meat in the country (Bornatowski et al. 2018a).

For several years, shark meat in Bahia was considered low quality meat (peixe de terceira) or muamba (characterizing a product of dubious origin) and therefore, displayed rather limited commercial value. Corroborating this, several fishers reported receiving these fish as gifts from boat owners in the past. Therefore, sharks were usually consumed only by fishers and their families and by the local population, comprising an important food source.

However, these fish have been gradually upgraded to the status of high-quality fish (peixe de primeira), leading to dramatic changes in shark meat catches and consumption by local Bahia fishers. Most interviewees (90.8%; n=59) reported a decrease in the number of sharks caught over time, following worldwide trends, where initial shark abundance has been replaced by a rapid population collapse, leading to decreased fishing yields (Stevens et al. 2000). Thus, shark access has become increasingly difficult for fishers, leading to increased market value. In this scenario, most respondents (70.7%, n=46) consider it more advantageous to sell captured sharks than to consume them, hindering fisher access to shark meat, particularly for those who do not own vessels. Therefore, fishers now complain they have lost the right to consume this product.

Local artisanal fishers in southern Bahia have different uses for shark byproducts such as meat, liver, jaws, teeth, cartilage, and even gills. These include

Table 1 Main shark species consumed and marketed by fishers in southern Bahia, Brazil.

Common name	Species	IUCN status	Brazil status
Cação-galha-preta	<i>Carcharhinus limbatus</i>	Not threatened	N/A**
Panã-galha-preta	<i>Sphyrna lewini</i>	Endangered	CR***
Panã-branca	<i>Sphyrna zygaena</i>	Vulnerable	CR
Panã-pintada	<i>Sphyrna tiburo</i>	Least Concern	CR
Panã-amarela	<i>Sphyrna tudes</i>	Vulnerable	CR
Cação-bico-doce	<i>Rhizoprionodon porosus</i>	Least Concern	N/A**
Cação-viola	<i>Pseudobatos percellens*</i>	Not threatened	N/A**

*This species belongs to the superorder Batoidea, but is considered a shark by the interviewees assessed herein; **Not available; *** Criticamente em perigo (= Critically Endangered).



Figure 2 Small sharks for sale at a street market in Ilhéus, Bahia. Photo credit: Márcio L. V. B. Filho, September 2012.

consumption, commercialization, and zootherapeutic, decorative-aesthetic and recreational applications. However, some of these historical uses, such as the use of liver oil for the treatment of human skin diseases or its commercialization for ethnoveterinary use in riding animals, are no longer observed. This may be due to the aforementioned lower regional frequency of local large shark catches observed in recent years, while other uses, such as fin commercialization, were non-existent 30 years ago and are currently being carried out at alarming rates (Barbosa-Filho et al. 2017).

Concerning shark size, most informants (86.9%, $n=53$) stated that the shark value per kilo is higher when the animal is less than one meter in length (locally termed *caçoês* or *caçonetes*) (Figure 2), ranging between R\$6.00 (US\$1.60) (R\$3.68=US\$1.00, in 30 January 2019) and R\$20.00 (US\$5.40). On the other hand, the market price of large sharks per kilo ranges from R\$3.00 (US\$0.80) to R\$8.00

(US\$2.17). For many species, individuals less than one meter in length have not yet reached reproductive age (Castro 2000). Regionally, immature sharks are preferred because they have the most tender and tasty meat, according to the interviewees. These preference motifs differ from those reported by Musick (2005), who, in a worldwide study on the different ways of using these fish, points out that small sharks are preferred for meat consumption because they generally display lower urea and mercury concentrations in relation to larger individuals. However, despite the consumption preference for younger specimens leading to serious implications for the conservation of these animals, the lack of scientific studies furthering into this shark consumption perspective hampers an adequate discussion of the subject.

Thus, actions aiming at educating fishers to the fact that they are capturing immature individuals should be adopted, as well as instructing them about the potential ecological impacts of capturing these animals in the juvenile phase. In addition, since sharks generally exhibit specific biological characteristics, such as late maturation, low fecundity, and low reproductive frequency, they become intrinsically susceptible to fishing impacts (Stevens et al. 2000). On the other hand, sharks are essential elements for the balance of these ecosystems, both in the control of prey populations and in exerting a strong evolutionary pressure when consuming old and diseased animals (Myers et al., 2007). In this sense, serious impacts to ocean ecosystems are currently noted due to the loss of apex predatory sharks, contributing to the occurrence of trophic cascades (Baum and Worm 2009; Myers et al., 2007) and trophic downgrading (Estes et al., 2011) in these environments. Given this context, the need to alert local fishermen to socio-environmental concerns regarding the capture and consumption of juvenile sharks becomes even more urgent.

Given that 54 species of marine elasmobranchs are currently threatened with extinction in Brazil, representing 37% of all species (ICMBIO, 2018), it is paramount to adopt campaigns aimed at discouraging shark meat consumption in the country. Sharks as a food source are one of the most expensive edible items in southern Bahia (Barbosa-Filho et al. 2017; Giglio et al. 2018) and, historically, shark meat has always been noted as an important protein source for underprivileged people in coastal areas located in

Northeastern Brazil (Lessa et al. 1999). Studies focusing not only on natural resource diversity, but also on their uses concerning human nourishment can generate relevant information regarding adequate resource management and conservation actions, while improving the nutritional and dietary status of these communities at the same time (Begossi et al. 2006; Bortolomial et al. 2018; van Vliet et al. 2018). In addition, the lack of studies on human ecology applying this approach emphasizes the need for scientific efforts capable of integrating biological and ecological information with socioeconomic issues.

Actions aiming at raising public awareness for the need to consume fish species comprising healthy stocks are also highly recommended, as a fear of fish stock collapses is necessary in order to incorporate consumer preferences into conservation strategies (McClenachan et al. 2016).

Alterations in ecological (decreasing catches), social (greater number of fishers employed on third party vessels instead of working on their own), and economic (higher local market shark value) spheres have significantly altered shark consumption trends among fishers. The current difficulty fishers face in consuming shark meat highlights an aspect that has not yet been adequately considered in conservation biology studies, namely food security threats. This is caused due to decreased dietary diversity, which in turn depends on natural resources that are currently suffering abundance declines and/or extinction processes; in this case, sharks. Further studies are required in order to expand the present knowledge concerning Southern Bahia local community diets, since reports suggest that the main commercially valued marine fish stocks are dwindling in this area (Bender et al. 2013).

Conclusions

The results reported herein reinforce previous findings reporting the use of sharks as a common practice in several Brazilian localities, suggesting a widespread practice in the country. Shark byproducts are used in multiple ways in southern Bahia and the impacts of these applications should be adequately assessed and contextualized. Information in this regard should be considered when implementing conservation plans, especially concerning highly exploited shark species. The information provided herein will aid in boosting conservation efforts regarding this important zoological group, both due to its significant ecological importance and its

contribution to human population food security and the biocultural heritage of coastal fishing communities.

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Declarations

Permissions: This study was carried out under the Santa Cruz State University Ethics Committee for Researches involving Humans number 01244412.3.0000.5526, obtained via the Brazilian Platform website.

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